

REMARKS

Claims 1-7 are pending in this application. Claim 1 has been amended. No new matter has been introduced.

Claim 1 has been amended to recite that the catalyst composition includes a catalyst support comprising 1 to 15 wt % beta zeolite and 1 to 15 wt % Y zeolite. Basis for this amendment is found on page 17, lines 15 to 21 of the specification. Claim 1 has been further amended to include a lowering of both the aromatic compound content and the pour point of the middle distillate.

Claims 1-7 are rejected under 35 U.S.C. §103(a) as being unpatentable over Ward (U.S. Patent No. 5,350,501) (“Ward”). This rejection is respectfully traversed.

At the outset, Applicants submit that one of the objectives of the process of the claimed invention is to provide hydrocracking of a hydrocarbon feedstock whereby the aromatic content of the prepared middle distillates is lowered, and the pour point is improved, compared to the same fraction in the hydrocarbon feedstock. This objective is achieved by catalyzing the process using a specific catalyst under specific operation conditions. The exact conditions required in a given situation depend on the nature of the feedstock, the particular catalyst composition used, and the desired product(s) (refer to page 24, lines 22 to 25).

The specific subranges for temperature and pressure recited in amended independent claim 1 are preferred hydrocracking conditions for single-stage operation or for each stage of a two-stage operation. The operating conditions do not need to be identical in each stage. Within these subranges, the temperature and the pressure can be adjusted to the values required for a specific conversion level of the hydrocarbon feedstock to the desired product i.e. middle distillates with low aromatic content, or to the distribution of products (see page 24, lines 10 to 18).

Amended independent claim 1 recites a catalyst comprising a catalyst support based on Y zeolite with a molar $\text{SiO}_2:\text{Al}_2\text{O}_3$ ratio of at least 15, and the beta zeolite having a silica-alumina

molar ratio of at least about 250. According to the invention, a high $\text{SiO}_2:\text{Al}_2\text{O}_3$ ratio for both zeolites is advantageous as they contribute to the formation of middle distillates with reduced aromatic content and improved pour point. This is shown in examples 1, 2 and 3 of the specification, where the $\text{SiO}_2:\text{Al}_2\text{O}_3$ molar ratios for zeolite beta are 1500:1, 1500:1 and 300:1 respectively, and 30:1 for zeolite Y.

Improved pour point and reduced aromatic content are observed with the inventive process. It is known in the art that zeolite Y with high silica-alumina ratio is suitable for producing middle distillates with low aromaticity, whereas zeolite beta is not known to have this effect. The Amendment filed on March 27, 2008 addressed in detail the unexpected lowering of the aromatic content observed with the catalyst used in the process of the claimed invention, when compared to processes using zeolites beta and Y individually. Both zeolite beta and zeolite Y in combination having high silica-alumina ratio have been found to have zeolitic properties and are catalytically active and contribute to improving the pour point and reducing the aromatic content of middle distillates.

In view of the above remarks, the subject matter of claims 1-7 would not have been obvious over Ward. The cited prior art reference does not disclose or suggest all limitations of amended independent claim 1. Ward discloses $\text{SiO}_2:\text{Al}_2\text{O}_3$ molar ratios for zeolite beta of at least 10 and up to about 100, with a preferred range of 10 to 40. The molar ratio of zeolite beta is not indicated in most of the examples, but in example 1 it is as low as 26. Ward states that $\text{SiO}_2:\text{Al}_2\text{O}_3$ molar ratios of 500:1 or more can be used, though they may have little or no zeolitic properties (see col. 4, lines 3-9). This is contrary to the findings of the claimed invention, where molar ratios of as high as 1500:1 for zeolite beta have been observed to be zeolithically active in low aromatic middle distillate production.

Similarly, Ward discloses low $\text{SiO}_2:\text{Al}_2\text{O}_3$ molar ratios for zeolite Y of preferably 4.5 to 9 and exemplified are values of 5.2 and 5.7 (refer to example 1, preparation of catalysts 2 and 3). Thus, Ward teaches the use of zeolites with low $\text{SiO}_2:\text{Al}_2\text{O}_3$ ratios for both zeolite beta and zeolite Y. A person skilled in the art would not have been motivated by Ward to use zeolite Y with a molar

SiO₂:Al₂O₃ ratio of at least 15 or zeolite beta with high SiO₂:Al₂O₃ molar ratio of at least 250, since Ward discloses that the former compound preferably uses low molar ratios and the latter compound has little or no zeolitic properties. Thus, Ward teaches away from the claimed invention and does not provide any hint at the synergistic effect observed with respect to reduced aromaticity and improved pour point of middle distillates (as in the claimed process) when using a combination of zeolites beta and Y having the claimed SiO₂:Al₂O₃ molar ratios.

Amended independent claim 1 also recites a catalyst support comprising 1 to 15 wt % a beta zeolite and 1 to 15 wt % Y zeolite as being suitable for carrying out the inventive process. To produce high yields of low aromatic middle distillate, weaker acidity and strong hydrogenation activity of the catalyst is required to minimize secondary cracking and maximize aromatic saturation. The low content of the beta zeolite and zeolite Y, both of which have low acidity due to the high silica-alumina ratio, ensures a very low acidity of the catalyst support and, in combination with a high hydrogenation /acidity ratio, ensures high degree of aromatic saturation. This aspect is exemplified in examples 1 to 3 (for instance), where the sum of the content of zeolite beta and zeolite Y totals 10 wt %. This low concentration is shown to have a positive effect leading to a reduction in aromatic content (refer to the results shown in table 3 of the specification).

Ward also mentions low concentrations of 5 to 50 wt % of combined amounts of zeolite beta and zeolite Y as being suitable for selectively producing middle distillates (refer to col. 8, lines 26 to 44). However, in all the examples, a total zeolite amount of 64% is used, resulting in a catalyst acidity that is much higher than that of the catalysts used in the inventive process and thereby having a high cracking activity. Thus, the hydrogenation/acidity ratio is low, and aromatic compounds are not hydrogenated but cracked instead, and this zeolite combination is thus more suitable for preparing gasoline than middle distillates. This is confirmed by the results in table II, which show that catalysts 2 and 3 provide increased activity for light gasoline with boiling point range 50-185°F (10-85°C) and naphtha within boiling point range 185-420°F (85-215°C) and for the lower end of middle distillates 300-550°F (148-288°C).

Ward discloses in table IV the selectivity vol. % converted to turbine fuel at activity temperature 300-550F (148C-287F) and to diesel at activity temperature 300-700F (148-371F), using catalyst 9. The selectivity vol. % for these two fractions shows that the amount of diesel formed from 550F to 700F corresponds to a selectivity vol. % of 5.7, which is very low, indicating that catalyst 9 is not suitable for producing heavy diesel, which is formed primarily at the high activity temperature. There is no mention of the aromatic content of the diesel prepared.

Catalyst 9 of Ward is identical to catalyst 2, and there is no available information regarding the beta zeolite used in catalyst 2. However preferable silica-alumina values for the beta zeolite are 20-30 and the Y zeolite used in catalyst 2 has a silica-alumina ratio of 5.2, both values being much lower than the silica-alumina values of the catalyst used in the process of the claimed invention. Catalysts 2 and 9 are thus not identical to the catalyst used in the process of the claimed invention, and they also are not able to produce high amounts of diesel.

The process of the claimed invention provides a low aromatic middle distillate product with lower pour point. The lowering of the pour point is a distinct improvement and allows the end point of the diesel fraction to be, if not limited, increased significantly; thus, due to increased boiling range, the process of the claimed invention results in increased production of middle distillates. These advantages are neither disclosed nor suggested by Ward.

Allowance of all pending claims is solicited.

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